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COMMERCIAL STANDARD CS75–56

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Automatic Mechanical-Draft Oil Burners Designed for Domestic Installations

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OFFICE OF TECHNICAL SERVICES
Commodity Standards Division

With the cooperation of
NATIONAL BUREAU OF STANDARDS

COMMERCIAL STANDARDS

Commercial Standards are developed by manufacturers, distributors, and users in cooperation with the Commodity Standards Division of the Office of Technical Services, and with the National Bureau of Standards. Their purpose is to establish standard methods of test, rating, certification, and labeling of manufactured commodities, and to provide uniform bases for fair competition.

The adoption and use of a Commercial Standard is voluntary. However, when reference to a standard is made in contracts, labels, invoices, or advertising literature, the provisions of the standard are enforcible through usual legal channels as a part of the sales contract.

Commercial Standards originate with the proponent industry. The sponsors may be manufacturers, distributors, or users of the specific product. One of these three elements of industry submits to the Commodity Standards Division the necessary data to be used as the basis for developing a standard of practice. The Division, by means of assembled conferences or letter referenda, or both, assists the sponsor group in arriving at a tentative standard of practice and thereafter refers it to the other elements of the same industry for approval or for constructive criticism that will be helpful in making any necessary adjustments. The regular procedure of the Division assures continuous servicing of each Commercial Standard through review and revision, whenever, in the opinion of the industry, changing conditions warrant such action.

SIMPLIFIED PRACTICE RECOMMENDATIONS

Under a similar procedure the Commodity Standards Division cooperates with industries in the establishment of Simplified Practice Recommendations. Their purpose is to eliminate avoidable waste through the establishment of standards of practice for sizes, dimensions, varieties, or other characteristics of specific products; to simplify packaging practices; and to establish simplified methods of performing specific tasks.

The initial printing of Commercial Standard CS75–56 was made possible through the financial cooperation of the Oil-Heat Institute of America, Inc.

Automatic Mechanical-Draft Oil Burners Designed for Domestic Installations

(Third Edition)

[Effective October 15, 1956]

1. GENERAL

1.1 PURPOSE.

1.1.1 The purpose of this Commercial Standard is to establish minimum standard specifications and methods of test for automatic mechanical draft oil burners for the guidance of manufacturers, distributors, installing contractors, and users.

1.2 SCOPE.

1.2.1 This standard covers:
(a) General requirements.
(b) Manufacturing and production tests.
(c) Laboratory requirements and test procedure.
(d) Installation requirements and performance tests.
(e) Placing of oil burner certificate with each burner installation.

1.2.2 This standard does not cover commercial fuel oil burners. A burner having a capacity of more than 8 gal/hr is considered to be a commercial burner for the purpose of this standard. (See par. 4.1 (a).)

1.3 DEFINITIONS.

1.3.1 *Automatic oil burner.*—A burner provided with an automatic device or devices which control the temperature of the heating medium either directly or indirectly.

1.3.2 *Mechanical-draft oil burner.*—An oil burner through which air for combustion is supplied by a power-driven fan shall, for the purposes of this standard, constitute a mechanical-draft oil burner.

1.3.3 *Primary control.*—An automatic device to prevent the abnormal discharge of oil in the event of ignition failure or premature flame extinguishment.

1.3.4 *Pull-through type.*—Oil-burning equipment which employs a power-operated exhaust fan to draw the products of combustion from the combustion chamber and discharge them into the flue-gas outlet.

1.3.5 *Manufacturer.*—For the purposes of this standard, the manufacturer shall be the company or organization which evidences its responsibility to the purchaser by:
(a) Permanently affixing its name, address, or nationally registered trademark or trade name to the burner.
(b) Permanently affixing its nationally registered trademark or trade name to the outside of the cover of the primary control if supplied as a separate part, in the event it does not already

bear the nationally registered trademark or trade name of the control manufacturer.

(c) Printing its name, address, or nationally registered trademark or trade name on the certificate.

(d) Printing its name, address, or nationally registered trademark or trade name on the instruction manual.

(e) Having its name and address listed in the Underwriters' List of Inspected Appliances.

2. GENERAL REQUIREMENTS

2.1 Burner Construction.

2.1.1 *Motors.*—Oil burner service may be assumed to be equivalent to continuous operation, and the motor shall be of ample capacity, shall be designed for continuous duty, and shall be so designated by the motor manufacturer on the motor nameplate. Motors shall comply in every respect with the current standards of the National Electrical Manufacturers Association for general purpose, special purpose, or oil burner motors, and relating to the following subjects as covered in NEMA Motor and Generator Standards Publication No. 45–102 (June 1945), or latest revision:

Classifications.
Voltage ratings.
Frequencies.
Horsepower and speed ratings.
Field windings.
Temperature rise.
Dielectric test.
Allowable variations from rated voltage.
Nameplate marking.
Direction of rotation.
Frame designation.
Allowable variation from rated frequency.
Allowable combined variation of voltage and frequency.

2.1.2 *Motor loading.*—The motor shall be capable of continuous operation at maximum normal burner load. It shall be provided with overcurrent protection as specified by the National Electrical Code.

2.1.3 *Radio interference.*—The burner shall cause no unreasonable amount of radio interference.

2.1.4 *Quietness.*—The burner shall be reasonably free from disturbing combustion or mechanical sound.

2.2 Burner Performance Ratings.

2.2.1 *CO_2 rating.*—The burner shall be capable of producing and maintaining the CO_2 in the flue gas at not less than 10 percent without visible smoke at all oil rates within the manufacturer's rated capacity.

2.2.2 *Smoke determination.*—After combustion has reached equilibrium, the amount of smoke in the flue gases shall not exceed that required to register a number 4 smoke on the approved smoke scale for laboratory tests, and shall not exceed a number 5 smoke for field tests. (See filter paper smoke method, par. 4.8.1 to 4.8.6.)

2.3 Burner Safety.

2.3.1 *Safety standard.*—The burner shall meet the safety standards of Underwriters' Laboratories, Inc., Standard for Domestic Oil Burners (Subject 296), March 1934, and subsequent revisions. Presence on the burner of label of Underwriters' Laboratories, Inc. shall be accepted as evidence of compliance with this safety requirement.

2.4 MANUALS.—A printed comprehensive service and installation manual shall be prepared and one or more copies shall be submitted by the burner manufacturer to the authorized laboratory for approval. The manufacturer shall furnish one or more copies of his service and installation manual to each of his authorized dealers.

2.5 TESTS.—Burner tests for certification shall be conducted according to test procedures established by this standard and approved by the oil-burner industry.

3. MANUFACTURING AND PRODUCTION TESTS

3.1 PRODUCTION TESTS ON PRESSURE OIL BURNERS.

3.1.1 Each burner shall be manufactured and tested as described herein.

3.1.1.1 The motor and pump shall be mounted to maintain factory alinement.

(a) When a resilient mounting is used for either the motor, pump, or both, and each is provided with a separate shaft and bearings, a flexible coupling or drive shall be used.

(b) The materials used in the flexible coupling or drive and in the motor and pump mountings shall not be deteriorated by contact with fuel or lubricating oil.

(c) The method of mounting the motor and/or pump shall be such that factory alinement can be obtained when parts are replaced in the field. Adjustable means of mounting the pump which can be permanently secured are acceptable.

3.1.1.2 All parts shall be interchangeable with like parts on like models.

3.1.1.3 The ignition points of electrodes shall be made of heat-resisting material and securely fastened to avoid change of location.

3.1.2 Each burner or its essential components shall be bench-tested.

3.1.2.1 The bench test shall be used to reveal and eliminate the following:

(a) Oil leaks.
(b) Electrical defects.
(c) Mechanical noise and vibration.
(d) Other defects.

3.1.2.2 The bench test shall be used to determine:

(a) Pressure-regulating valve adjustment.
(b) Total motor load.
(c) Proper adjustment of ignition means (with or without actual fire test).

3.1.3 The bench test shall be made at the maximum rated oil pressure recommended by the manufacturer in his installation manual, but in no case at less than 100 pounds per square inch for high-pressure atomization burners; for low-pressure and horizontal rotary domestic burners, the burner shall be tested at the maximum pressure recommended in the manufacturer's installation manual.

3.1.4 At the conclusion of the operating tests of each burner, the air gap between electrodes and the relation of electrodes to nozzle shall be inspected for acceptance, and shall be in accordance with the specifications contained in the manufacturer's manual for that particular model.

3.2 PRODUCTION TESTS ON WALL FLAME AND ATOMIZING VERTICAL ROTARY BURNERS.

3.2.1 Each burner shall be manufactured and tested as described herein.

3.2.1.1 The tolerances of all parts shall be established and checked with suitable gages or fixtures so that the burners can be assembled without altering the parts.

3.2.1.2 Motor shall operate as an assembly (motor and driven parts) and be checked for:

(a) Quiet operation.
(b) Shaft alinement.

3.2.1.3 Oil-distributing device shall be inspected for:

(a) Tube angle.
(b) Tube concentricity.

3.2.1.4 Fan shall be inspected for balance and runout.

3.2.1.5 Igniters shall be inspected for:

(a) Spark gap.
(b) Insulation.

3.2.1.6 Oil valve in its manufacture shall be tested for leakage.

3.2.1.7 Igniter lead wire shall conform to Underwriters' Laboratories specifications in all respects.

4. LABORATORY REQUIREMENTS AND TEST PROCEDURE

4.1 *Laboratory facilities and equipment.*—The equipment and facilities required by the laboratory for conducting the above tests as outlined shall include:

(a) Space for not less than six heating boilers varying in size, suitable for oil burners of capacities up to and including 8 gal/hr.
(b) At least three boilers covering the above range at the beginning of operations.
(c) A separate chimney or its equivalent for each boiler.
(d) Qualified mechanics for constructing refractory combustion chambers in accordance with drawings and specifications as submitted, and qualified mechanics for doing the necessary pipework, and mechanical assembly and adjustment in connection with the installation of burner.
(e) Approved sound-level meters and microphones.
(f) Approved radio-noise meters and accessories.
(g) Approved equipment for determining smoke.
(h) Approved flue-gas analysis equipment.
(i) Oil-rate flow meters or equivalent means for determining oil rates of burners in operation.
(j) Oil storage facilities.
(k) Accurate electric ammeters, voltmeters, and wattmeters.
(l) Accurate suitable draft gages.

4.2 *Burner construction—motor.*—The oil-burner unit as submitted for approval shall be equipped with a motor in accordance with paragraphs 2.1.1 and 2.1.2, and tests shall be run at the maximum normal load conditions to which this particular burner may be adjusted. The results of these tests shall indicate that the maximum motor loading is in accordance with paragraphs 2.1.1 and 2.1.2.

4.3 *Mechanical construction.*—The burner is to be inspected and checked for the following:

(a) Proper alinement between motor and pump.

(b) Interchangeability of all like parts on like models.
(c) Reasonable freedom from vibration and undue wear.
(d) Whether motor and pump are securely mounted in such manner that the alinement of these two units shall remain permanent within the specified tolerances.
(e) Whether the motor cannot be loaded in excess of its rated capacity under normal operating conditions.
(f) Whether ignition points of electrodes are made of heat-resistant material and securely fastened to avoid change of location.

4.4 *Safety standards.*—No burner shall be accepted at the authorized laboratory for inspection and test unless it complies with the requirements of paragraph 2.3.1.

4.5 *Drawings.*—A complete set of detail manufacturing blueprints and/or photographs, to be the same as required by the Underwriters' Laboratories, Inc., shall accompany each model and shall remain in the confidential custody of the laboratory.

4.6 *Installation and service manual.*—Each burner model submitted to the laboratory for test shall be accompanied by a printed comprehensive installation and service manual, and the laboratory shall review this manual and use the instructions therein contained for installing and testing the unit as submitted. The manual shall contain:

(a) Cross-sectional views of each model to disclose method of adjustments and replacement of parts.
(b) Combustion-chamber dimensions and construction.
(c) Oil-tank and piping diagrams and instructions.
(d) Electrical diagrams and instructions.
(e) Draft specifications and chimney information.
(f) Diagrams and instructions for installation adjustment and operation: (1) Electric controls and limits. (2) Combustion.
(g) Combustion air requirements of the furnace room.

4.7 *Laboratory rating test.*

4.7.1 Following the mechanical inspection outlined above, the burner shall be installed in a suitable boiler exactly in accordance with the installation instructions contained in the manufacturer's manual. After the burner is installed and during the entire period of its operating test, the entire boiler or furnace structure shall be maintained tight against air leakage so that infiltration of air into the combustion space or boiler passages cannot affect the flue-gas analysis readings at the boiler or furnace-flue outlet.

4.7.2 *Combustion performance.*—A burner submitted for test shall be operated on the heaviest grade of fuel for which it is approved by the Underwriters' Laboratories, and each model submitted shall be tested at its minimum and maximum firing rates, as indicated by the manufacturer, and at intermediate rates in steps of 1 gal/hr in the case of models that are rated over a range exceeding 1 gal/hr difference between the minimim and maximum rate.

4.7.3 *Test procedure.*—The test procedure shall begin with the manufacturer's minimum rating and continue in steps of not more than 1 gal/hr to the manufacturer's maximum rating. The flue-gas sample for analysis shall be taken at the boiler or furnace flue-gas outlet. Except for pull-through types, the draft value in the combustion chamber for this test shall be in accordance with the manufacturer's specifications, but in no case shall it exceed 0.03 inch of water for burners tested at 5 gal/hr or less, and shall not exceed 0.05

inch of water for burners tested at more than 5 gal/hr. This same draft value shall be used in determining the maximum burning rate.

4.7.3.1 In determining maximum burning rates for full mechanical-draft burners, all air for combustion shall be supplied by the burner fan or blower. Where maximum burning rates are designated by the manufacturer with partial mechanical draft, such maximum burning rates shall be qualified in terms of minimum draft and port area in manufacturer's manuals, rating, and instruction sheets. Where burners are *designed* for partial mechanical draft the maximum burning rates shall be qualified in terms of minimum draft and port area in manufacturer's manuals, rating, and instruction sheets.

4.8 *Smoke determination.*—After combustion has reached equilibrium, the amount of smoke in the flue gases shall not exceed that required to register a number 4 smoke on the approved smoke scale when tested by the filter paper method as described below:

Filter Paper Method for Determining Smoke Density in Flue Gases

4.8.1 *Outline of method.*—The filter paper method for determining smoke density in flue gases involves passing through filter paper, as specified below, a test flue-gas volume of 2,250 ($\pm$100) cubic inches (standard conditions) for each square inch effective surface area of filter paper used. Sampling device shall be of such construction that total travel of flue-gas sample from flue to filter paper shall not exceed 16 inches. Suitable laboratory and portable field service equipments are illustrated in figures 1 and 2.

The resultant test smoke spot on the test filter paper is measured to establish its color density by visual matching with a smoke scale, as specified below, consisting of 10 graded numbered spots ranging from white to black. The closest match determines the gross smoke spot number of the test spot. When making this comparison, test filter paper must be backed by a white surface having absolute surface reflectance of not less than 75 percent.

Net smoke spot number shall be determined by deducting from the gross smoke spot number, the smoke spot number obtained by matching the spot obtained on filter paper through which has been drawn a sample of air from the space from which the combustion air is being supplied, using the same equipment, filter paper, test volume, and evaluation as were used in measuring gross smoke spot number. In case of disagreement on the visual net or gross test spot number evaluation, the photometric smoke spot number evaluation described below shall be employed.

4.8.2 *Specification of filter paper.*—Test filter paper is required, made from white filter paper stock having absolute surface reflectance of between 82.5 percent and 87.5 percent determined by photometric measurement. When making this reflectance measurement, filter paper must be backed by a white surface having absolute surface reflectance of not less than 75 percent. When clean air is drawn through clean filter paper at a rate of 1,125 cubic inches (60° F, 1 atmosphere pressure) per square inch effective surface area of filter paper per minute, the pressure drop across the filter paper should fall between limits of 0.5 inch and 2.5 inches of mercury.

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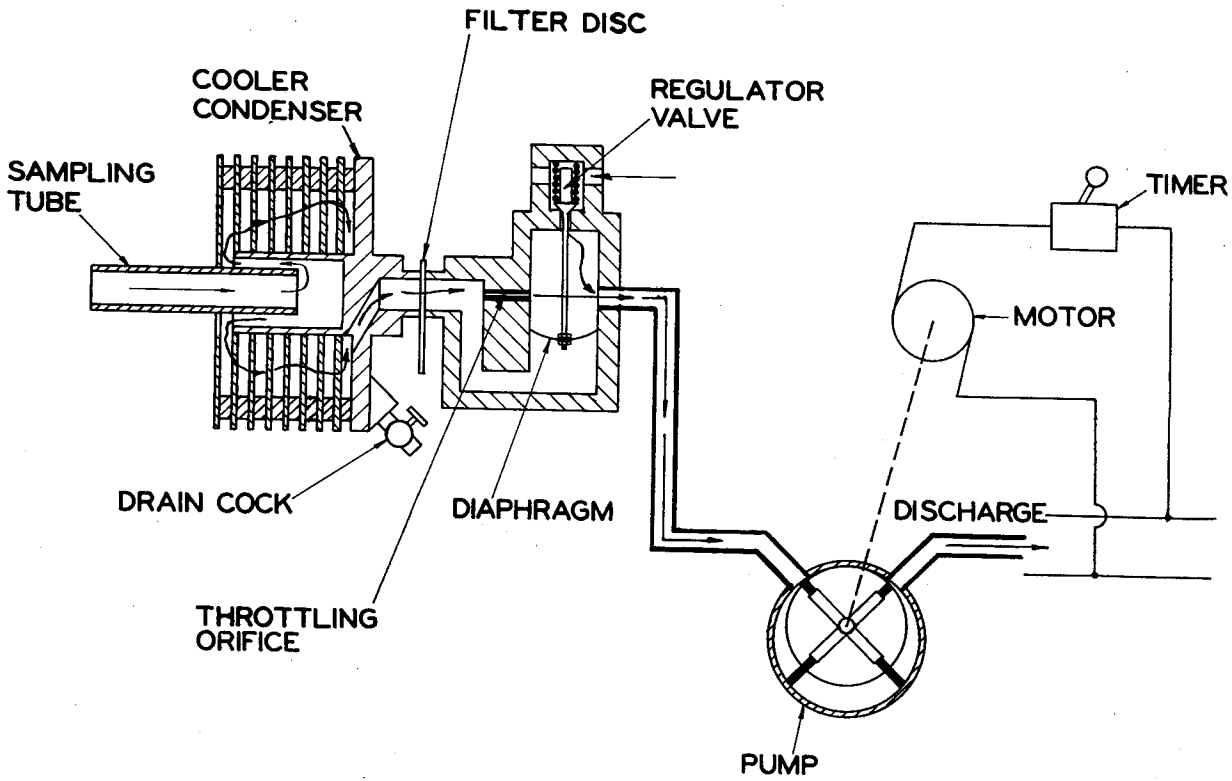

FIGURE 1. *Laboratory-type smoke meter.*

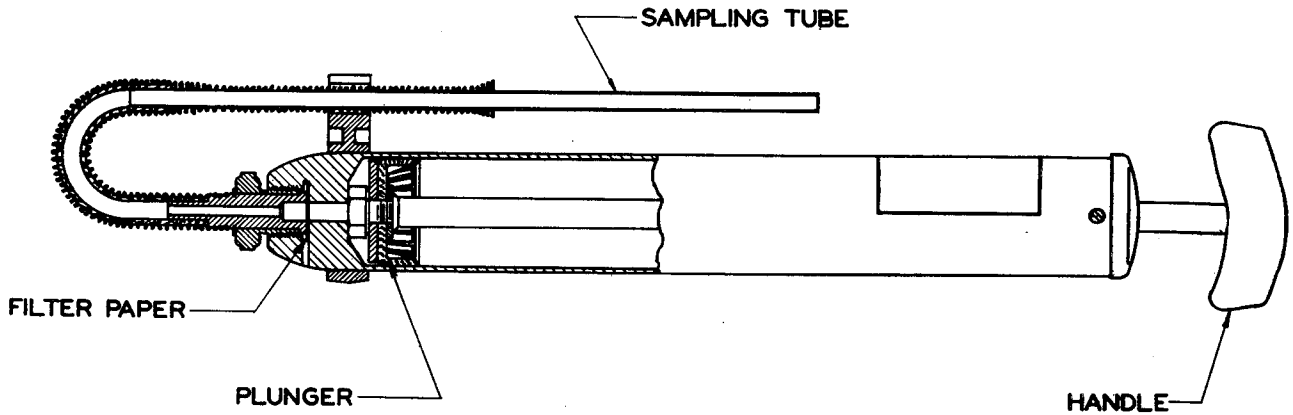

FIGURE 2. *Field-service-type smoke tester.*

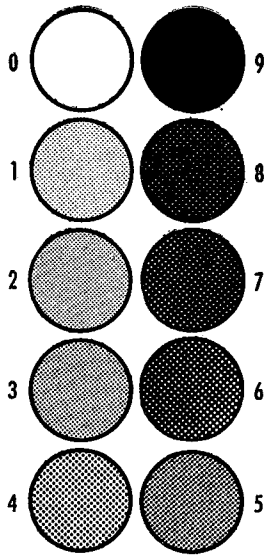

FIGURE 3. *Smoke scale for filter-paper method for determining smoke density in flue gases.*

(Caution: Above illustration is not a usable smoke scale.)

4.8.3 *Specifications of smoke scale.*—The smoke scale (fig. 3) required for use with the filter paper method consists of 11 spots consecutively numbered from 0 to 10 [1] ranging in equal photometric steps from white through neutral shades of gray to black, imprinted or otherwise processed on white paper or plastic stock having an absolute surface reflectance of between 82.5 and 87.5 percent, determined photometrically. The smoke scale spot number is defined as the reduction in reflected incident light (due to existence of soot) divided by 10. Thus, the first (perfectly white) spot, which is the color of the unimprinted scale, will be number 0, since there will be in the case of this spot no reduction in reflected incident light directed thereon. The last spot, however, is very dark, reflecting none of the incident light directed thereon; thus in this case the reduction in reflected incident light is 100 percent, which, divided by 10, gives to this darkest spot the number 10.[1] Intermediate spot numbers are similarly established. Limit of permissible reflectance variation of any smoke scale spot is not to exceed ± 3 percent relative reflectance. Such smoke scales are sufficiently accurate for field use and for many laboratory smoke testing applications. However, specially calibrated scales, known as certified smoke scales, sometimes will be required (as in the case of Underwriters' Laboratories, Inc. burner performance rating tests), for which the specifications are given in the following paragraph.

A certified smoke scale is obtained by individually calibrating each smoke spot of a normal smoke scale. The normal smoke scale is first mounted in the light beam of a suitable type of reflectance photometer, and the photometer is adjusted to read 100 percent when the light beam is directed at spot number 0. Each imprinted smoke scale spot

[1] It is permissible to omit the number 10 spot from the smoke meter scale, since the number 9 spot is sufficiently dark for fuel oil combustion applications.

is then in turn exposed to the photometer light beam and the percentage reduction in reflected light due to the imprinting measured. Each smoke scale spot number is then established by the percentage reduction in incident light divided by 10. These precise smoke spot numbers expressed in decimal values to the nearest tenth shall then be furnished with the suitably identified scale.

Where the smoke scale is protected with a plastic or transparent cover, the construction employed shall be such that when the smoke spot on the filter paper is viewed for matching with the numbered spots on the smoke scale, both shall be visible through the same thickness and number of sheets of transparent protective cover.

4.8.4 *Photometric test spot number evaluation.*—The human factor involved in visually comparing filter paper test spots with smoke scale spots can be eliminated by resort to direct use of a suitable photometer for evaluating test spots. To make this direct photometric test spot evaluation, the following procedure shall be employed: Filter paper backed by material having absolute surface reflectance of not less than 75 percent shall be mounted in the light beam of a suitable type of reflectance photometer with beam focused on a clean, unused surface of the filter paper adjacent to the smoke spot, and the photometer adjusted to read 100 percent reflectance in terms of the light reflected from this clean surface. Test smoke spot on filter paper shall then be exposed to the photometer light beam and the percentage reduction in reflected light due to the presence of smoke particles on and in the filter paper shall be measured. Gross smoke spot number shall be defined as equal to this percentage reduction in reflected light divided by 10. Net smoke spot number shall be determined by deducting from the gross smoke spot number the smoke spot number determined by measurement of a filter paper through which has been drawn a duplicate sample of air from the space from which combustion air is being supplied, using the same equipment, filter paper, test volume, and calculation as were used in measuring gross smoke spot number.

4.8.5 *Specification of photometer.*—The photometer to be employed for direct test spot number evaluation shall be of the electrically operated reflectance type employing a barrier layer cell, fitted with special means to accommodate filter paper test disks. It is to be furnished complete with green tristimulus filter and with reflectance standards of approximately 20, 40, 60, and 80 percent absolute reflectance, to permit photometer readings between 10 and 90 percent relative reflectance (relative to clean filter paper) to be made within ± 2 percent accuracy.

4.8.6 *Availability of smoke meters, filter paper, scales, and photometers.*—Suitable instruments and accessories for both field and laboratory testing are commercially available. Inquiry regarding current sources of supply should be directed to Underwriters' Laboratories, Inc., 207 East Ohio St., Chicago, Ill.

4.9 *Radio interference.*—The burner shall cause no unreasonable amount of radio interference.

4.10 *Noise.*—A burner shall be reasonably free from disturbing combustion and mechanical sounds.

4.10.1 *Tests.*—Suitable noiseproof enclosures are to be provided for the burner and its boiler when under test, and noise readings are to be taken in accordance with American Standards Association procedure as applying to domestic equipment. The standard of permis-

sible sound level shall be determined by the testing laboratory as the result of accumulated experience, subject to the approval of the oil burner industry through its standards committee.

4.10.1.1 Sound-level readings are to be taken of the burner—

(a) Operating without flame.

(b) Operating with flame and at minimum and maximum burning rates.

5. INSTALLATION REQUIREMENTS AND PERFORMANCE TESTS

5.1 Installation Requirements.

5.1.1 *Size.*—The burner shall be of adequate size for the boiler or furnace and the connected heating load as recorded on the oil burner certificate by the installer.

5.1.2 *Location of furnace.*—The furnace shall be so placed as to provide adequate space for servicing the burner.

5.1.3 *Certificate.*—Following installation of the burner, certain test data shall be obtained and recorded by the installer on the oil burner certificate to be placed with each oil burner installation. The test shall cover the following: CO_2 in the flue gas by analysis, draft, stack temperature, firing rate, and smoke. The oil burner certificate shall be printed (not mimeographed) in a minimum size of 8½ by 11 inches, with all the printing on one side, and shall be posted and protected by transparent material.

5.1.4 *Requirements.*—The standard requirements as approved by the industry are as given herein.

5.1.4.1 *CO_2.*—The CO_2 in the flue gas by analysis shall be not less than 8 percent.

5.1.4.2 *Draft.*—The draft shall be in accordance with specifications in the manufacturer's installation manual. An automatic draft regulator or its equivalent is required.

5.1.4.3 *Stack temperature.*—The stack temperature shall be measured on the boiler side of automatic draft regulator and not more than 12 inches from the boiler smoke connection. The stack temperature shall be measured at the certified firing rate. If an automatic draft regulator is built into the boiler or furnace, such regulator shall be closed when the stack temperature is measured.

5.1.4.4 *Firing rate.*—The firing rate shall be based on the burner manufacturer's recommendation for the existing total connected load. Burner shall be fired at that rate as a minimum, but not to exceed 25 percent additional for the maximum rate. The firing rate at which the burner is set shall be within the firing range for which the burner has been approved by the laboratory, and not more than the firing rate designated on the boiler, furnace, or unit, or designated by the manufacturer of the boiler, furnace, or unit.

5.1.4.5 *Smoke.*—A field smoke test shall be made when the burner has been in operation for 15 minutes. The amount of smoke in the flue gases shall not exceed that required to register a number 5 smoke on the approved smoke scale (see par. 4.8.1 to 4.8.6).

5.1.4.6 *Installation manual.*—The burner shall be installed in accordance with manufacturer's installation manual. These instructions shall include, prominently displayed, the requirement that the furnace be so placed as to provide adequate space for servicing the burner.

5.2 INSTALLATION TEST PROCEDURE.

5.2.1 *Equipment.*—The following equipment shall be available on each oil burner installation before the tests are started.

5.2.1.1 Where the oil rate is not indicated on the nozzle tip, a suitable device for determining the rate in terms of gallons per hour fed to the burner shall be used. This may be in the form of a graduated glass vessel.

5.2.1.2 A suitable flue-gas analyzer for determining the percentage of CO_2 in the flue gases.

5.2.1.3 A suitable draft gage, graduated in hundredths of an inch of water.

5.2.1.4 A suitable thermometer to indicate the flue-gas temperatures.

5.2.1.5 Provisions for inserting a thermometer into the flue pipe as follows: Not more than 12 inches from the boiler or furnace outlet, measured on the centerline of the flue pipe, there shall be a hole not more than ½ inch in diameter, located at the side of the pipe on the centerline, so that the thermometer may be inserted horizontally. The thermometer is to be placed so that the sensitive element is one-fourth of the pipe diameter from the near side of the flue pipe. The opening around the thermometer stem shall be sealed to prevent air leakage. This same opening may be used for checking draft and sampling flue gases.

NOTE.—Other things being equal, flue-gas temperature indication may be expected to be higher by some 50° F if the smoke pipe is insulated. Stack temperature is largely controlled by boiler design. High stack temperatures do not necessarily condemn the burner.

5.2.1.6 Approved field-service smoke-testing equipment.

5.2.1.7 In addition to the above, provision shall be made on the boiler or furnace for inserting a small tube into the combusion chamber for measuring the draft. The area of the opening shall not exceed that of a ½-inch-diameter round hole (¼-inch pipe tap).

5.2.2 *Test procedure.*—The test procedure is as follows:

5.2.2.1 The burner shall be operated and the fuel rate adjusted to that required for the particular installation.

5.2.2.2 The draft then shall be adjusted to meet the burner manufacturer's specifications, both over the fire and at the breeching.

5.2.2.3 Combustion-air adjustments are to be made to give the highest CO_2 in the flue gas without exceeding a number 5 smoke on the approved smoke scale (see par. 4.8.1 to 4.8.6). If the minimum required percentage of CO_2 cannot be obtained in the breeching, it will be permissible to take CO_2 over the fire, which will be acceptable. In that event, both CO_2 readings shall be recorded on the certificate. A considerable difference between the two CO_2 readings indicates a leak of air into the flue passes or firebox of the boiler.

5.2.2.4 Stack temperature shall be recorded after 10 minutes of operation after reaching steaming temperature for steam boilers, or 180° F water temperature for hot-water boilers, or 125° F bonnet temperature for hot-air heating plants.

5.2.3 *Readings.*—During the period of operation to permit flue-gas temperatures to reach maximum, periodic readings of draft, CO_2, and oil rate shall be taken and the average recorded on the certificate. All controls and limiting devices shall be checked for proper operation.

OIL BURNER CERTIFICATE

As required by Commercial Standard CS75-56

The _____ (Make) oil burner Model No._____

Serial No. _____ installed at _____ (Address of installation) bears a label evidencing compliance with Commercial Standard CS75–56, and has been installed in accordance with the instructions in the manufacturer's installation manual and in conformity with local regulations, codes, and ordinances.

The boiler ( ), furnace ( ), is a _____ (Make) No. _____,

and the heating load consists of:

1. _____ Btu, or _____ square feet steam ( ), hot water ( ) radiation; and
2. _____ Btu, or _____ square feet of equivalent steam ( ), hot water ( ) radiation in domestic hot-water load; or
3. _____ Btu, or _____ square inches of cross-sectional area of warm-air supply pipes measured at the furnace takeoff; or
4. _____ Btu, or _____ square feet of equivalent steam ( ), hot water ( ) radiation in the following special load:

All necessary permits have been secured, and the installation has been tested in accordance with the test procedure of Commercial Standard CS75–56, and the following readings taken:

CO_2 — {Over fire_____ / At breeching__} _____ Stack temperatures at breeching ____°F

Draft — {Over fire_____ / At breeching__} inches H_2O. Firing rate_____ gal/hr.

All controls and limiting devices have been checked for proper operation _____.
Fuel used, grade No. _____ of Commercial Standard CS12–48.
Field-service equipment smoke scale reading_____.

The above test results are certified to be true.

For service, call:

_____ (Name)

_____ (Address)

_____ (Telephone)

Date _____

_____ (Name of company making installation)

Per _____ (Signature)

_____ (Address)

_____ (Telephone)

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6. SIGNIFICANCE OF INSTALLATION REQUIREMENTS AND PERFORMANCE TESTS

6.1 The oil-burner certificate posted after installation is the guaranty or affidavit to the ultimate consumer that the installation complies with these minimum standards. The significant factors of the various recorded data on this certificate are summarized as follows:

6.1.1 *CO_2 (carbon dioxide)* is one of the products of combustion of fuel oil. Its percentage by volume under prescribed test conditions is an important index of the *quality* of the combustion performance of the burner. High CO_2 with no chimney smoke shows that the burner has been designed, installed, and adjusted so well it needs little excess air to give a clean fire. It will be noted that the manufacturing laboratory standards prescribe a minimum performance of 10 percent of CO_2, whereas the installation standards permit a minimum of 8 percent of CO_2. This difference takes into account the effect of variables that are impracticable to control under normal operating

conditions to the extent possible under laboratory test procedure and supervision.

6.1.2 Lower CO_2 may or may not be a reflection on the design of the burner itself, but may be caused by (1) improper burner air-shutter adjustment, (2) poor atomization of the fuel, (3) improper flame shape, (4) improper size, shape, or material of combustion chamber or combustion hearth, (5) excessive or uncontrolled draft, (6) underfired boiler or furnace, and (7) air leaks in boiler or furnace setting. This latter cause is often due to improper installation of boiler or furnace. These standards provide a definite means of checking this condition by stating that when the minimum CO_2 of 8 percent cannot be obtained in the breeching, it will be permissible to take a CO_2 reading over the fire, in which case both readings must be recorded on the certificate. CO_2 considerably higher over the fire than in the breeching (1 or 2 percent or more) is an indication of a sizable air leak into the flue-gas passages of the boiler or furnace, which should be located and sealed. In new boilers the installer of the boiler or furnace is responsible for the location and correction of such air leaks. In any event, the installer of the oil burner should immediately advise the purchaser of this condition when it is encountered, particularly in those cases where it is not corrected.

6.1.3 *Draft* intensity depends upon the height of the chimney and the temperature difference between the outside air and the chimney gases. The capacity of the chimney is determined by the draft intensity and the cross-sectional area of the chimney. The function of the chimney and draft is to dispose of the products of combustion from the boiler or furnace. Either too high or too low a draft may adversely affect the performance of the burner and heating plant; therefore, a draft regulator is required by these standards to adjust high or low drafts to acceptable values within reasonable limits, that is, high enough to dispose of the combustion gases so that smoke or odor nuisance is not created, and at the same time, low enough to maintain economical operation. Any feature of design, construction, or use which impairs the proper functions of the chimney is likely to cause combustion difficulties; therefore, any additional openings in a chimney connected to the central heating plant, such as for fireplaces, stoves, heaters, or vents, should be eliminated.

6.1.4 *Stack temperature* shows how well a furnace or boiler absorbs the heat released in it by the burning fuel. It is largely controlled by boiler or furnace design, although the burner design, application, or adjustment also may be responsible for increasing stack temperatures above normal. The principal causes of high stack temperature directly related to the burner or burner installation are (1) improper size or shape of combustion chamber, (2) excessive firing rate adjustment, (3) excessive draft, and (4) dirty boiler or furnace flues. Given proper burner application and performance for the connected heating load, and assuming clean heating surfaces in boiler or furnace, and proper water conditions where a steam boiler is used, high stack temperatures generally indicate (1) an undersized boiler or furnace, or (2) insufficient or poorly designed heating surface in the boiler or furnace.

6.1.5 To properly evaluate stack temperatures, they must be considered in relation to CO_2 for the purpose of determining the stack loss, or percentage of heat in the fuel burned which goes up the chimney. Below is a chart showing this relationship. It will be noted

that with 8 percent of CO_2 and a stack temperature of 400° F, the stack loss is approximately 18 percent; with 13 percent of CO_2 the stack temperature can be increased to 600° F without increasing the percentage of stack loss. While excessively high stack temperatures are usually objectionable because of increased stack loss, excessively low stack temperatures due either to poor design or underfiring of boiler or furnace may be equally objectionable in that they may be inadequate for the maintenance of proper draft; and further, the condensation, in the chimney, of water vapor from the combustion gases can be highly destructive to certain materials.

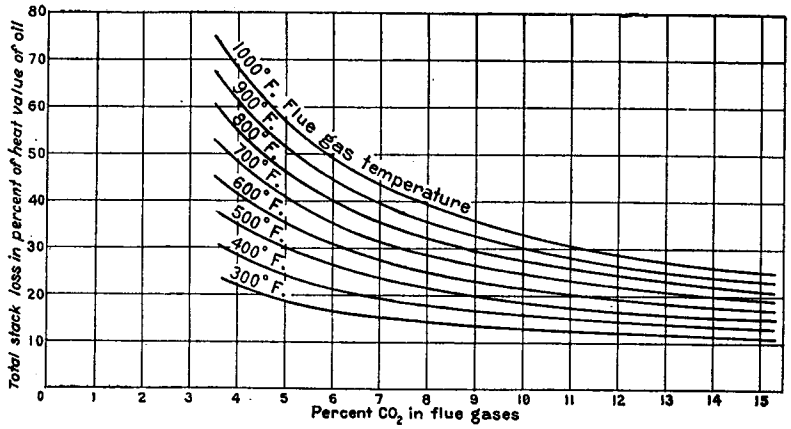

FIGURE 4. *Stack loss curves for combustion of domestic oil-burner distillates. (Technical Bulletin No. 109, U. S. Department of Agriculture.)*

6.1.6 *Firing rate* is important in that it must be adequate in the coldest weather to supply the requirements of the total connected load, which includes installed radiation or its equivalent, allowance for piping loss, reserve for pickup, and allowance for domestic hot water where supplied by the heating system; and at the same time avoid creating a condition that may cause excessive stack temperatures or uneconomical operation for the reasons discussed above. The 25-percent excess firing rate permitted in the standards should not be used except where required to offset deficiencies in boiler or furnace capacity or deficiencies in installed radiation or equivalent.

6.1.7 *Smoke* is unburned carbon in the combustion gases and is evidence of improper burner application or adjustment. Smoke should not be confused with the appearance of condensed water vapor in the products of combustion, sometimes visible as a light haze at the top of the chimney.

6.1.8 *Controls* are required to be tested as an additional precaution to prove accuracy of electrical work and instrument adjustment before allowing automatic operation of the equipment.

6.2 It is recommended that printed guaranties, service agreements, and operating and maintenance instructions regularly furnished by the manufacturer and/or installer, or as may be additionally required by the purchaser, shall be posted on or adjacent to the burner.

7. MANUFACTURER'S CERTIFICATE

7.1 In order that purchasers of oil burners may become familiar with the significance of minimum standard requirements and tests, as a basis for fair competition and improved confidence in oil-burner performance, it is recommended that the following statement be included in manufacturers' warranties, labels, invoices, contracts, sales literature, etc.:

> This oil burner is certified by the ---------- Company (manufacturer) to comply with the requirements of Commercial Standard CS75–56, as developed by the trade under the procedure of the Commodity Standards Division, and issued by the U. S. Department of Commerce. It bears the seal of the official inspection agency of the oil burner industry evidencing compliance with its requirements.

8. EFFECTIVE DATE

8.1 Having met all the procedural requirements of the Commodity Standards Division, including approval by the acceptors hereinafter listed, this Commercial Standard was issued by the United States Department of Commerce, effective from October 15, 1956.

EDWIN W. ELY,
Chief, Commodity Standards Division.

HISTORY OF PROJECT

First edition.—Following a series of industry-wide meetings for the purpose of developing standards for mechanical-draft oil burners, the oil burner industry standards committee, on February 17, 1939, requested the National Bureau of Standards to cooperate in the establishment of a Commercial Standard for mechanical-draft oil burners. A preliminary manufacturer-distributor conference, held on March 15, 1939, reviewed and revised a proposed draft of the standard.

The proposed standard was then circulated to producers, distributors, installing contractors, and users for comment and criticism, and a general conference of those directly concerned was held on April 27, 1939, in Washington, D. C. This conference further revised the draft and recommended that it be circulated to the trade for written acceptance. Accordingly, the recommended Commercial Standard was submitted to producers, distributors, and users on May 12, 1939. Following written acceptance by a satisfactory majority, an announcement was issued that the new standard, designated CS75–39, Automatic Mechanical-Draft Oil Burners Designed for Domestic Installations, would become effective for new production on November 1, 1939.

First revision.—On October 2, 1941, the oil burner industry standards committee submitted a proposed revision of the standard, which was approved by the standing committee. This revision was circulated on November 21, 1941, to the industry for acceptance. Having been approved by a satisfactory majority, the revised standard, designated CS75–42, became effective for new production on July 20, 1942.

Second revision.—On April 20, 1945, at the instance of interested organizations, a proposed revision of CS75–42 was submitted to the standing committee for review. This draft was adjusted in accordance with the suggestions of various organizations, and referred to the standing committee on November 27, 1945. Subsequently, as a result of

further study of the provisions and requirements, a number of additional changes were made in the proposed revision during 1950 and 1952.

The recommended revision was circulated to the industry for written acceptance on March 10, 1953. After further adjustments, and following acceptance of the revised standard by a satisfactory majority, an announcement was issued on September 15, 1954, that CS75–56 would become effective for new production on October 15, 1956. Mimeographed copies of CS75–56 were prepared for distribution, which contained a statement worded as follows:

Preface.—The requirements of this Commercial Standard concerning all subjects excepting smoke testing shall be considered in effect beginning October 15, 1954. The Underwriters' Laboratories has requested, and the standing committee has approved, a 2-year delay in the effective date for smoke testing, because that period will be required to complete tests on the various makes and models of burners. Compliance with the smoke testing requirement will become effective October 15, 1956.

During the 2-year interval, burners complying with the new requirements, including smoke testing, will retain the CS75–42 label and become eligible for the CS75–56 label on October 15, 1956. The CS75–42 label will *not* be retained beyond October 15, 1956.

Project Manager: H. A. Bonnet, Commodity Standards Division, Office of Technical Services.
Technical Adviser: R. S. Dill, Heating and Air Conditioning Section, Building Technology Division, National Bureau of Standards.

STANDING COMMITTEE

The following individuals comprise the membership of the standing committee, which is to review, prior to circulation for acceptance, revisions proposed to keep the standard abreast of progress. Comments concerning the standard and suggestions for revision may be addressed to any member of the committee or to the Commodity Standards Division, Office of Technical Services, United States Department of Commerce, which acts as secretary for the committee.

R. M. Sherman, Silent Glow Oil Burner Corp., Hartford, Conn. (Chairman).
C. F. Suesserott, General Electric Co., Tyler, Tex.
C. M. Pierson, Eureka-Williams Co., Bloomington, Ill.
Chas. A. Reif, Reif-Rexoil, Inc., 37 Carroll St., Buffalo 3, N. Y.
Graydon Peoples, Lennox Industries, Inc., Marshalltown, Iowa.
Ray G. Whipple, Harvey Whipple, Inc., Springfield, Mass.
D. H. Bottrill, Oil Heat Institute of America, Inc., 500 Fifth Ave., New York 36, N. Y.
Frederick Beckwith, Oil Heat Institute of New England, 839 Beacon St., Boston 16, Mass.
Dayle G. Malone, Petroleum Heat & Power Co., 3301 South California Ave., Chicago, Ill. (representing Chicago Oil Burner Association, Inc.).
J. C. Campbell, Elliott-Lewis Corp., 444 North 16th St., Philadelphia 30, Pa. (representing Electrical Association of Philadelphia).
A. C. Jenkins, Jenkins Engineering Co., 518 Virginia St., Seattle, Wash. (representing Oil Fuel Dealers Association).
C. S. Vernon, Jr., Heating Division, Sinclair Refining Co., 401 Farragut St. NE., Washington 11, D. C.
L. N. Hunter, National Radiator Co., Johnstown, Pa. (representing the Institute of Boiler & Radiator Manufacturers).

WILLIAM VAN ALEN, New York Chapter AIA, 141 East 52d St., New York, N. Y.
(representing American Institute of Architects).
MRS. CHARLOTTE LEYDEN, National Council of Women of the United States,
345 East 46th St., New York 17, N. Y.
M. W. MERRILL, U. S. Metals Refining Co., 400 Middlesex Ave., Carteret, N. J.
(representing National Association of Purchasing Agents).
Housing & Home Finance Agency, 1626 K St. NW., Washington 25, D. C.
(Invited to name a representative.)

WITHDRAWN

CS75-56

ACCEPTANCE OF COMMERCIAL STANDARD

If acceptance has not previously been filed, this sheet properly filled in, signed, and returned will provide for the recording of your organization as an acceptor of this Commercial Standard.

Date_____

Commodity Standards Division
Office of Technical Services
U. S. Department of Commerce
Washington 25, D. C.

Gentlemen:

We believe that Commercial Standard CS75–56 constitutes a useful standard of practice, and we individually plan to utilize it as far as practicable in the

production [1] distribution [1] purchase [1] testing [1]

of automatic mechanical-draft oil burners.

We reserve the right to depart from the standard as we deem advisable.

We understand, of course, that only those products which actually comply with the standard in all respects can be identified or labeled as conforming thereto.

Signature of authorized officer _____
(In ink)

(Kindly typewrite or print the following lines)

Name and title of above officer _____

Organization _____
(Fill in exactly as it should be listed)

Street address _____

City, zone, and State _____

(Cut on this line)

[1] Underscore the one that applies. Please see that separate acceptances are filed for all subsidiary companies and affiliates which should be listed separately as acceptors. In the case of related interests, trade associations, trade papers, etc., desiring to record their general support, the words "General support" should be added after the signature.

TO THE ACCEPTOR

The following statements answer the usual questions arising in connection with the acceptance and its significance:

1. *Enforcement.*—Commercial Standards are commodity specifications voluntarily established by mutual consent of those concerned. They present a common basis of understanding between the producer, distributor, and consumer and should not be confused with any plan of governmental regulation or control. The United States Department of Commerce has no regulatory power in the enforcement of their provisions, but since they represent the will of the interested groups as a whole, their provisions through usage soon become established as trade customs, and are made effective through incorporation into sales contracts by means of labels, invoices, and the like.

2. *The acceptor's responsibility.*—The purpose of Commercial Standards is to establish, for specific commodities, nationally recognized grades or consumer criteria, and the benefits therefrom will be measurable in direct proportion to their general recognition and actual use. Instances will occur when it may be necessary to deviate from the standard and the signing of an acceptance does not preclude such departures; however, such signature indicates an intention to follow the standard where practicable in the production, distribution, or consumption of the article in question.

3. *The Department's responsibility.*—The major function performed by the Department of Commerce in the voluntary establishment of Commercial Standards on a nationwide basis is fourfold: first, to act as an unbiased coordinator to bring all interested parties together for the mutually satisfactory adjustment of trade standards; second, to supply such assistance and advice as past experience with similar programs may suggest; third, to canvass and record the extent of acceptance and adherence to the standard on the part of producers, distributors, and users; and fourth, after acceptance, to publish and promulgate the standard for the information and guidance of buyers and sellers of the commodity.

4. *Announcement and promulgation.*—When the standard has been endorsed by a satisfactory majority of production or consumption in the absence of active valid opposition, the success of the project is announced. If, however, in the opinion of the standing committee or of the Department of Commerce, the support of any standard is inadequate, the right is reserved to withhold promulgation and publication.

ACCEPTORS

The organizations listed below have individually accepted this standard for use as far as practicable in the production, distribution, testing, or purchase of automatic mechanical-draft oil burners designed for domestic installations. In accepting the standard they reserved the right to depart from it as they individually deem advisable. It is expected that products which actually comply with the requirements of this standard in all respects will be regularly identified or labeled as conforming thereto, and that purchasers will require such specific evidence of conformity.

ASSOCIATIONS

(General Support)

Central Supply Association, Chicago, Ill.
National Association of Purchasing Agents, New York, N. Y.
National Council of Women of the U. S., Inc., New York, N. Y.
Oil-Heat Institute of America, New York, N. Y.
Oil Heat Institute of New England, Boston, Mass.

FIRMS AND OTHER INTERESTS

Adams, Franklin O., Tampa, Fla.
Aldrich Co., Wyoming, Ill.
American Radiator & Standard Sanitary Corp., Pittsburgh, Pa.
Andrews, Jones, Biscoe & Goodell, Boston, Mass.
Automatic Burner Corp., Chicago, Ill.

Bacharach Industrial Instrument Co., Pittsburgh, Pa.
Baumer, Herbert, Columbus, Ohio.
Beckett, R. W., Corp., Elyria, Ohio.
Brooks-Borg, Des Moines, Iowa.
Brust & Brust, Milwaukee, Wis.

Cannon & Mullen, Salt Lake City, Utah.
Century Engineering Corp., Cedar Rapids, Iowa.
Cincinnati, City of, Department of Purchasing, Cincinnati, Ohio.
Coleman Co., Inc., Wichita, Kans.
Columbia Boiler Co., Pottstown, Pa.
Conrad & Cummings, Binghamton, N. Y.
Consumers Petroleum Co., Chicago, Ill.
Cram & Ferguson, Boston, Mass.
Cramer, H. Leslie, Needham, Mass.

Darby, Bogner & Associates, Milwaukee, Wis.
Detroit, City of, Department of Public Works, Detroit, Mich.
Dongan Electric Manufacturing Co., Detroit, Mich.

Electrol Burner Manufacturing Co., Inc., Rutherford, N. J.
Evans Products Co., Plymouth, Mich.

General Heating Engineering Co., Inc., Washington, D. C.
General Machine Co., Inc., Emmaus, Pa.

Harris, Jay, New York, N. Y.
Hart Heat Division, Avery Farm Machinery Co., Peoria, Ill.
Heating Supply Co., Inc., Rochester, N. Y.
Heil Co., Milwaukee, Wis.
Henry Furnace Co., Medina, Ohio.
Hess Co., Chicago, Ill.
Holland Furnace Co., Holland, Mich.

Indoor Comfort Heating & Ventilating Co., Rockford, Ill.
International Oil Burner Co., St. Louis, Mo.

Keich, O'Brien & Steiner, Warren, Ohio.
Kleen-Heet, Inc., Chicago, Ill.
Kleer Kleen Manufacturing Co., Hayward, Calif.
Kresky Manufacturing Co., Inc., Petaluma, Calif. (General support.)
Kresno Stamm Manufacturing Co. (America), Inc., Palisades Park, N. J.

Law, Law, Potter & Nystrom, Madison, Wis.
Lennox Furnace Co., Marshalltown, Iowa.
Levy, Will, St. Louis, Mo.

Majestic Co., Inc., Huntington, Ind.
Major Oil Burner Co., Philadelphia, Pa.
Malleable Iron Fittings Co., Branford, Conn.
Mann & Co., Hutchinson, Kans.
Martino, A. R., Co., Waterbury, Conn.
Massey, Wood & West, Inc., Richmond, Va.
Metromatic Manufacturing Co., Everett, Mass.
Meyer Furnace Co., Peoria, Ill.
Middleton & Meads Co., Inc., Baltimore, Md.
Miller & Vrydagh, Terre Haute, Ind.
Minneapolis, City of, Department of Buildings, Minneapolis, Minn.
Montag Stove & Furnace Works, Portland, Oreg.
Mooser, William, San Francisco, Calif.
Morgan Oil Burner Service, Cortland, N. Y.

New York Central System, New York, N. Y.
New York Testing Laboratories, Inc., New York, N. Y.
Nu-Way Corp., Rock Island, Ill.

Olsen, C. A., Manufacturing Co., Elyria, Ohio.

Parks, J. C., Heating Co., Greenville, S. C.
Pehrson, G. A., & Associates, Spokane, Wash.
Pennsylvania, Commonwealth of, Bureau of Standards, Department of Property and Supplies, Harrisburg, Pa.
Perfection Stove Co., Cleveland, Ohio.
Preferred Utilities Manufacturing Corp., New York, N. Y.

Quiet-Heet Manufacturing Corp., Newark, N. J.
Quincy Oil Co., Quincy, Mass.

Ray Oil Burner Co., San Francisco, Calif.
Reif-Rexoil, Inc., Buffalo, N. Y.
Ritchie, James H., & Associates, Boston, Mass.
Ruple Heating Co., Schenectady, N. Y.
Russell, Mullgardt, Schwarz, Van Hoefen, St. Louis, Mo.

Shell Oil Co., New York, N. Y. (General support.)
Sherwood Bros., Inc., Baltimore, Md.
Silent Glow Oil Burner Corp., Hartford, Conn.
Sinclair Refining Co., Washington, D. C.
Sundstrand Machine Tool Co., Rockford, Ill.
Swarthmore Heating Service, Swarthmore, Pa.

Taco Heaters, Inc., Providence, R. I.
Taylor, Ellery Kirke, Haddonfield, N. J.
Timken Silent Automatic Division, Rockwell Spring & Axle Co., Jackson, Mich.
Toridheet Division, Cleveland Steel Products Corp., Cleveland, Ohio.

Underwriters' Laboratories, Inc., Chicago, Ill. (General support.)
United States Radiator Corp., Detroit, Mich.